# Estimating the Economic Impact of Secondhand Smoke in Marion County, Indiana

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Brittany S. Sutton, MPH
Terrell W. Zollinger, DrPH
Robert M. Saywell, Jr, PhD

ABSTRACT

Introduction: This study updates the estimate of the health-related costs of secondhand smoke (SHS) exposure to the residents of Marion County, Indiana, using current data.

Methods: Costs of SHS related mortality and morbidity were estimated using national attributable risk values for diseases that are known to be causally related to SHS exposure both for adults and children. Estimated costs included ambulatory care costs, hospital inpatient costs, and loss of life costs based on hospital discharge data, vital statistics, and census data. Attributable risk values were applied to the number of Marion County deaths in 2007 and hospital discharges in 2005 to estimate the number of individuals impacted by SHS exposure. All cost estimates were adjusted to 2008 dollar values.

Results: The overall cost of health care and premature loss of life attributed to SHS for Marion County residents was estimated to be $47.5 million in 2008 -- $10.5 million in health care costs and $7 million in loss of life for children compared to $7.8 million in health care costs and $22.2 million in loss of life for adults. The estimated population for Marion County in 2007 was 872,842 resulting in SHS related costs of $54.44 per capita.

Conclusions: The results of this study provide data estimates needed to educate the public, community leaders, and local policy makers about the health effects and costs of SHS exposure in Marion County.

# INTRODUCTION

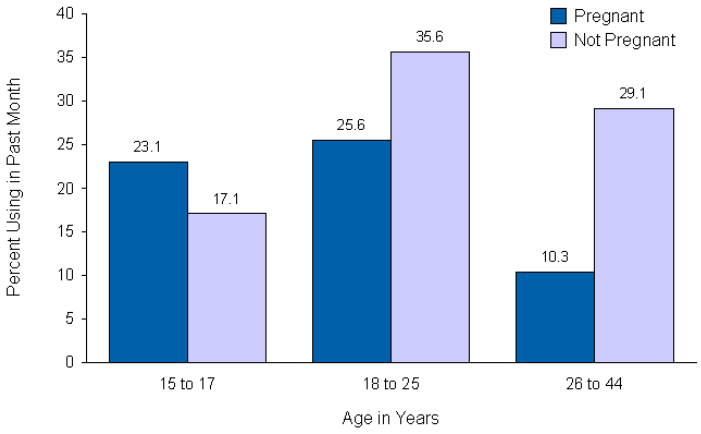
Exposure to secondhand tobacco smoke (SHS), also known as environmental tobacco smoke, passive smoking, or involuntary smoking is a significant contributor to adult and childhood morbidity and mortality in the United States.[1-4] SHS is a complex mixture of gases and particles comprised of smoke from burning cigarettes, cigars or pipe tobacco (side stream smoke), mainstream smoke that is not inhaled by the smoker, and exhaled tobacco smoke. Side stream smoke and mainstream smoke contain the same chemical constituents including at least 250 chemicals known to be toxic or carcinogenic.[1] Exposure of adult nonsmokers to SHS has been causally associated with many medical conditions, including lung cancer, nasal sinus cancer, breast cancer, cervical cancer, ischemic heart disease (myocardial infarction and arteriosclerosis), stroke, eye and nasal irritation, spontaneous abortions and asthma.[2-5] In addition, other studies have suggested that exposure to SHS may be causally associated with adult leukemia, angina pectoris, hearing loss, allergies, periodontal disease, dysmenorrhea, colds, pneumonia, meningococcal disease, macular degeneration, congestive heart failure and cardiac arrhythmia.[2, 7-22] Exposure of children to SHS has been linked to low birth weight, sudden infant death syndrome, respiratory syncytial virus bronchiolitis, asthma exacerbations, otitis media, chronic respiratory symptoms, cystic fibrosis exacerbation, Legg-Perthes disease, allergies, meningococcal disease, loss of hearing and cognitive behavioral impairment.[2-4, 12-13, 15-16, 23-27] Also, many children[4] and adults are injured from fires started by smoking. The Centers for Disease Control and Prevention (CDC) report that any level of exposure to SHS can be dangerous.[28]

SHS exposure continues to be a major public health concern. First, about one-fifth (19.8%) [29, 30] of the adult U.S. population smoke. More of the adult current smokers in the U.S. are male most often between the ages of 18-34, are Black/African-Americans, earn less than $25,000 per year, and have less than a high school education. The trends are the same for Indiana, except more of the current smokers are white. CDC estimates that 25.5% of adults in Marion County were current smokers in 2007.[29] These data suggest that there are many significant opportunities for non-smokers to be exposed to SHS.

**Behavioral Risk Factor Surveillance System, 2007**
**Adult Smokers in Indiana and the United States**

| | Indiana | United States |
|---|---|---|
| **Adults who are current smokers** | 24.1% | 19.8% |
| **Males who are current smokers** | 25.9% | 21.2% |
| **Females who are current smokers** | 22.5% | 18.4% |
| **18-24 years of age** | 29.8% | 24.0% |
| **25-34 years of age** | 30.7% | 23.9% |
| **35-44 years of age** | 25.8% | 20.4% |
| **45-54 years of age** | 27.2% | 22.3% |
| **55-64 years of age** | 21.7% | 18.0% |
| **65 year of age and older** | 9.5% | 9.0% |
| **White** | 24.0% | 19.4% |
| **Black** | 22.9% | 21.7% |
| **Hispanic** | 25.1% | 16.7% |

Percent of Pregnant and Non-Pregnant Women Currently Smoking, 2006, United States




Second, many children are exposed to the effects of smoking before birth. The Department of Health and Human Services Substance Abuse and Mental Health Services Administration reports that smoking rates among young women ages 15 to 17 were higher for those who were pregnant (23.1%) than among those not pregnant (17.1%).

Furthermore, the combined 2005 and 2006 data show that about 16.5 percent of pregnant females reported "cigarette use during the past month." [31] Third, it has been estimated that nearly 60 percent of the children in the United States children are exposed to SHS in the home.[28]

Much work has been done to protect non-smokers from the deleterious effects of SHS with about 65 percent of the U.S. population and 40 percent of the Indiana population being protected by smoke-free laws as of April 2008 [32] as a result of numerous studies that have reported the link between SHS exposure and morbidity and mortality among both adults and children. However, little is available in the scientific literature regarding the economic consequences of these adverse SHS related health effects. A recently study from Minnesota[33] used Blue Cross/Blue Shield claims estimated the cost to be $44.58 per capita (2003 data) compared to an earlier estimate for Marion County of $62.68 per capita (2000 data).[34] However, it should be noted that the smoking rate for adults in Minnesota was substantially lower than the smoking rates for adults in Indiana (16.5% Minnesota vs. 24.1% Indiana) according to the 2007 BRFSS.[35] Using 2006 and 2007 data the estimated economic impact for the state of Indiana was $61.51 per capita.[36]

The purpose of this report is to update the earlier estimate of the costs of health care and premature loss of life resulting from SHS exposure in Marion County, Indiana using data from 2005 and 2007.

## METHODS

Costs of SHS related mortality and morbidity were estimated using national attributable risk values for diseases that are known to be causally related to SHS exposure

for both adults and children. Estimated costs included ambulatory care costs, hospital inpatient costs, and loss of life costs based on hospital discharge data, vital statistics and census data. Attributable risk values were applied to the number of deaths in 2007 and hospital discharges in 2005 to determine the number of individuals impacted by SHS exposure in Marion County.

This study used national research based attributable risk values, community-based demographic data from the U.S. Census Bureau (2008), disease incidence in the community (i.e. disease-specific hospitalizations in 2005), average hospital charges for the selected diseases, median age of death for SHS related diseases, and an estimated economic value of life. The estimated attributable risk values were obtained from articles and reports identified in searches of major literature databases. Of these, three were the primary sources used for this study: 1] the 2005 California EPA Report,[2] 2] the 2006 Surgeon General's Report[3] and 3] a study conducted by Aligne and Stoddard.[4] The major data source was the California EPA (CalEPA) report which provided the basis for many of the health effects cited in the 2006 Surgeon General's Report.[3] The CalEPA report summarized several research studies that presented values based on thorough reviews of meta-analyses, literature syntheses, and epidemiological studies in both the U.S. and in other industrialized countries. Peer-review publication and frequency of article citations were also considered by CalEPA in selecting the articles used as sources of the attributable risk values. When more than one value was presented in the CalEPA report, this study used the estimates from the strongest study design or median estimate if the studies were equivalent in design. Furthermore, the sources used in the CalEPA report considered the sample sizes of the studies, the extent to which the studies accounted for

confounding factors, selection bias when comparing groups or bias in ascertaining exposure, and the generalizability to the U.S. population.

Questionnaire based assessments of exposure to SHS were the most widely used methods to evaluate individuals' exposure to tobacco smoke. Questionnaires have important advantages: they are relatively inexpensive; they can be feasibly administered in a variety of ways, including mail surveys, telephone surveys, or in person; and, they are able to assess both current and past exposures. The disadvantages include difficulties in validation, particularly of a past exposure and the potential for misclassification.[37-38] Measures of exposure in the studies included in the CalEPA report were often based on self-report questionnaire based assessments. However, the 2006 Surgeon General's Report[3] focused on the importance of using biomarkers to assess exposure. Biomarkers are more specific, sensitive, and objective, which are necessary qualities for program evaluation and community surveillance. Evidence suggests that prevalence of tobacco smoke exposure is significantly underestimated when using questionnaires. Data from the Third National Health and Nutrition Examination Survey (NHANES III) showed a detectable level of cotinine in 88 percent of nonsmoking adults.[39] which is much higher than community questionnaire studies examining exposure to tobacco smoke.[40] A significant limitation of using biomarkers, however, is that biomarkers measure only current exposure, not lifetime exposure to tobacco smoke. In addition, obtaining access and cooperation of study participants to gather specimens for biomarker studies are more costly and the logistics are more difficult. Questionnaires can be used to measure historical exposure, although recall biases do exist. Finally, evidence shows that there is a

strong correlation between both sources of exposure assessments.[39, 41-45] Thus, while use of biomarkers may be preferred, well-designed questionnaires can produce valid results.

The attributable risk values used in the current study were based on research using current measures of exposure from both questionnaires and biomarkers. While these decisions were dictated by available research, it is believed that the result actually yields more conservative measures of attributable risk.

*SHS Adult Morbidity Costs:*

The formula used to calculate the hospitalization costs for each specific attributable disease in adults was:

Hospitalization Costs = AR * H *CH

Where:

AR is the attributable risk of getting the disease if exposed to SHS;

H is the number of hospitalizations in Marion County during 2005 for the specific disease;

CH is the average charge per hospitalization for the specific disease, adjusted to 2008 dollars.

Attributable risk values for specific diseases were specified in the CalEPA report.[2] When multiple attributable risks were reported, the attributable risk from the study with the strongest design, or the median when all designs were equivalent, was used. The number of hospital discharges and hospitalization costs for the specific diseases were obtained from the 2005 annual hospital discharge summaries prepared by the Indiana Hospital Association and provided to the Marion County Health Department.

*Limitations in Estimating SHS Adult Morbidity Costs:* The major limitations that affect the validity of this approach to estimate adult morbidity costs relate to data gaps and underlying assumptions. First, annual costs of outpatient care, emergency room care, and prescriptions for the specific diseases were not available and were not included this component of the cost estimates. Second, costs of pain and suffering were not included in this model. Third, only those diseases with well-documented attributable risks for SHS exposure were included. Fourth, this model assumed that the percent of costs attributed to treatment of the specific diseases caused by SHS exposure is the same as the percent of cases of disease that are attributed to secondhand exposure. Finally, it was assumed that the attributable risk values found in the published literature apply to the population in Marion County.

*SHS Adult Mortality Costs:*

The mortality costs for each condition attributed to SHS were calculated using the following formula:

$$\text{Loss of Life Costs} = AR * D * VL * [(LE - AD)/LE]$$

Where:

AR is the attributable risk of getting the disease if exposed to SHS;

D is the number of deaths in Marion County in 2007 for the specific disease;

VL is the estimated value of a full life ($3,706,148 -- inflated to 2008 dollars);

LE is the life expectancy; and,

AD is the average age of death for the specific disease.

The term [(LE – AD)/LE] estimates the proportion of a person's life that is lost due to premature death.

The information needed to calculate these costs included: the disease-specific attributable risk for SHS exposure, the number of deaths for the specific diseases (based on Marion County death certificates for 2007 deaths), an estimate of the value of life, life expectancy (reported by the National Center for Health Statistics based on 2005 deaths), and the average age at death for the specific diseases. The same attributable risk values were used for the loss of life estimates as for the costs of hospitalization.

To determine the loss of life costs, the estimated monetary value of life was obtained from the United States Department of Transportation.[46] The guidance recommended that the value be set at $3,000,000 in 2000. This value was inflated by the consumer price index to $3,706,148 in 2008 using the U.S. Department of Labor consumer price inflator.[47] Thus, $3,706,148 was used as the estimate the economic value of a human life (to life expectancy) in the equation.

The median age at death for causes attributed to SHS exposure was subtracted from the average U.S. life expectancy of 77.8 years for 2005 [48] and divided by this average life expectancy (77.8 years) to determine the percent of life lost. This percent of life lost was multiplied by the value of life estimate and then multiplied by the number of SHS attributable deaths for each illness to obtain an estimated dollar value for the SHS-attributable loss of life.

*Limitations in Estimating SHS Adult Mortality Costs:* There are several limitations related to estimating of the costs of adult mortality from SHS exposure. First, only those diseases with well-documented attributable risks for SHS exposure were included in our application. Second, it was assumed that the attributable risk values found in the published literature apply to the Marion County population. A third concern

is that there may not be agreement on the actual value of a full life, since this is a difficult and subjective variable to quantify. Fourth, this model used the life expectancy at birth, which provides a conservative estimate of the proportion of life lost. A more accurate measure would be to use life expectancy at the time the individual began being exposed to SHS; however, that age was unknown. Hospital discharge data for 2005 were used for this study. Although those data are several years old, it is expected that disease-specific hospitalization rates are fairly constant over a short period of time.

*SHS Child Morbidity and Mortality Costs:*

The model for estimating child morbidity and mortality was structured differently to take advantage of the data provided by Aligne and Stoddard.[4] The number of cause-specific deaths of children in Marion County for 2007 was provided by the Marion County Health Department. However, the cases of specific diseases or events for children were not known for Marion County; thus, the following estimation procedure was used. The first step was to estimate the number of events in children using a ratio of the values provided by Aligne and Stoddard to the U.S. population for the particular age group, using this formula:

$$E_{SC} = P_{SC} * (E_{US} / P_{US})$$

Where:

$E_{SC}$ is the estimated number of events in the sub-population of children in Marion County for the applicable disease;

$P_{SC}$ is the number in the applicable sub-population of children in Marion County based on the U.S. Census estimates of children living in Marion County during 2008;

$E_{US}$ is the number of events in the U.S. for the disease in the applicable sub-population; and,

$P_{US}$ is the number in the applicable sub-population based on the U.S. Census reported estimates of children living in the U.S. during 2008.

This calculation was used to determine an estimate of the initial number of events for the Marion County population. The attributable risk estimates, also reported by Aligne and Stoddard, [4] were then applied to the estimated number of events in Marion County. An estimate of the number of events among Marion County youth that can be attributed to SHS exposure was then obtained using the formula:

$$E_{SHS} = AR * E_{SC}$$

Where:

$E_{SHS}$ is the number of events in Marion County attributable to SHS;

AR is the SHS attributable risk of getting the disease if exposed to SHS; and

$E_{SC}$ is the estimated total number of events in Marion County among both the exposed and non-exposed applicable sub-populations.

Before applying the costs per case estimates reported by Aligne and Stoddard [4] to the number of events, the costs were adjusted to year 2008 dollars, using the medical care category of the consumer price indices established by the U.S. Department of Labor.[47] Finally, the cost estimates for the SHS attributable events were determined by multiplying the costs per event by the number of SHS attributable events in Marion County, using the formula:

$$C_{SHS} = C_E * E_{SHS}$$

Where:

$C_{SHS}$ is the cost of disease attributable to SHS in Marion County;

$C_E$ is the cost per event (doctor's visit, hospitalization, surgery, etc.) for each disease adjusted to 2008 U.S. dollars; and,

$E_{SHS}$ is the number of events related to each of the diseases in Marion County attributable to SHS.

The Aligne and Stoddard[4] data included the number of office visits, hospitalizations, surgeries and deaths of each SHS-related pediatric illness. Their data were used because outpatient and surgery data were not available for Marion County.

*Limitations in Estimating SHS Costs in Children:* The method used to estimate the costs of exposure to SHS for children relies heavily on the data presented in the Aligne and Stoddard[4] article. The findings in their study (attributable risk, utilization, and cost of care) may not be representative of Marion County in a different year, although that assumption is made for this study. Also, the diseases included in their analysis may not be exhaustive of diseases that can be attributed to SHS exposure. Thus, using only the diseases and conditions in their study would underestimate the actual costs of SHS exposure. Also, the Aligne and Stoddard[4] study did not include all sources of health care, such as emergency room and pharmacy costs, which, if included, would have increased the cost of these diseases significantly. Finally, the cost of pain and suffering of the children and their parents were not included in their study thus, were omitted from this model.

## Results

The numbers of hospital discharges for the seven conditions attributable to SHS for adults in Marion County are shown in Table 1. While morbid conditions result in

many types of contacts with the health care system (doctor's visits, hospitalizations, pharmacy, etc.), only hospitalization data were available for the adult population in Marion County. Hospital costs were adjusted to year 2008 dollars using the medical care category of the consumer price index from 2005 to 2008.[47]

The deaths for the causes attributable to SHS exposure in Marion County are also shown in Table 1. The mortality statistics were also used to determine the median ages at death from these causes, which were needed to calculate the cost of loss of life.

Table 2 presents the estimated incidence of morbidity and mortality for SHS related medical conditions among children. The number of deaths and low birth weight deliveries were obtained from the birth and death records provided by the Indiana State Department of Health. The number of children receiving health care (hospitalizations, office visits, and surgeries) was determined by applying the estimated number of children in Marion County derived from the 2007 U.S. Census estimates to rates calculated from numbers published in the Aligne and Stoddard article.[4] For example, the number of office visits for otitis media for children less than 14 years old, as reported by Aligne and Stoddard,[4] was divided by the total number of children less than age 14 in the United States (using 2007 census data) to get a national rate of office visits by children in this age group with otitis media. This rate was then multiplied by the total number of children less than 14 years of age in Marion County from the 2007 census to obtain the estimated number of office visits for otitis media in Marion County.

*SHS Adult Morbidity and Mortality Costs:*

Table 1 presents the estimated incidence, attributable risk, and costs of health care and loss of life of SHS related medical conditions for adults. The overall cost of

hospitalizations for adults in Marion County attributed to SHS was estimated to be $7,780,804. The loss of life costs for these same conditions was estimated to be $22,248,007. Combined, the SHS morbidity and mortality costs for adults attributed to SHS totaled $30,028,811 in Marion County.

*SHS Child Morbidity and Mortality Costs:*

Table 2 presents the estimated incidence, attributable risk, and costs of health care and loss of life for SHS related medical conditions for children in Marion County. The overall costs of health care for children were estimated to be $10,502,466. The estimated loss of life costs for these same conditions were $6,982,382. Combined, the SHS attributable morbidity and mortality costs for children were estimated to total $17,484,828.

Thus, the total economic impact on the health of Marion County residents was estimated to be $47,513,639. Since the 2007 population of Marion County was estimated to be 872,842[49] the total per capita health cost of secondhand smoking in Marion County was estimated to be $54.44 per person.

## Discussion

Exposure to SHS is not only a significant health concern, but a significant economic concern as well. The purpose of this study was to provide a model to estimate the health-related costs of SHS exposure on a county level. It was estimated that in 2008, $18,283,250 was spent in Marion County for the hospitalization and health care of patients with diseases attributed to SHS exposure. Additionally, in 2008 approximately $29,230,389 was lost due to premature death that can be attributed to SHS exposure. The total cost (health care costs and the cost of premature loss of life) for diseases attributed

to SHS in Marion County was estimated to be $47,513,639 in 2008 or about $54.44 per person. These costs do not include the health care and loss of life costs of Marion County residents who are smoking.

It is widely known that tobacco use contributes to the increased incidence of disease and premature loss of life in those who smoke; however, many do not recognize the impact of a person's smoking on his or her spouse, children, family members, friends, co-workers and customers. The adult smoking rates in Indiana are higher than the nation as a whole. While the rate of smoking among adults in the U.S. was 19.8 percent, Indiana's adult smoking rate was 24.1 percent in 2007.[36] It has been estimated that nearly 60 percent of the U.S. population is exposed to SHS in their homes.[3] Since the adult smoking rate in Indiana is higher than the national average, it is reasonable to infer that adults and children in Indiana are exposed to SHS at a higher rate as well.

The health-related costs arising from SHS exposure could be avoided or reduced in two ways. First and most obvious, individuals could quit smoking. Second, those who continue to smoke tobacco should be discouraged from smoking in their home, their automobile, their workplace and other places where non-smokers might be exposed to SHS. Comprehensive workplace no smoking laws are needed to protect the health of workers in all work place environments, including restaurants, bars and clubs. If they do not already fall under a community smoking restriction, business owners and managers could consider making their businesses smoke-free. However, such policies need to have the support of the public and one's employees. This requires that people clearly understand the magnitude of the consequences of SHS both from an individual health perspective as well as from an economic perspective. In a survey of 20 states measuring

attitudes about SHS, Indiana was among the states with the lowest public support favoring restrictions on smoking, including smoke-free policies in work areas, no smoking in restaurants and prohibiting indoor smoking work areas.[51] Examining the trend in attitudes about secondhand smoke policies in Indiana over the seven years from the Adult Tobacco Survey found a significant increase in the proportion of individuals who do not allow smoking in their homes, the proportion who are aware that exposure to secondhand smoke causes cancer, heart disease and sudden infant death syndrome, and the proportion who are concerned about the health effects of exposure to secondhand smoke. There has been a decrease in the proportion of workers who are exposed to cigarette smoke in their work places, and a decrease in the proportion of individuals who have been in a car where someone was smoking.

Given the high incidence of smoking and the relatively weak policies and poor attitudes related to SHS, Indiana continues to be at high risk for incurring high SHS related costs. More effective public policies related to SHS need to be developed in the State of Indiana to achieve lower health care costs and improved overall health status.

The costs of SHS in addition to its impact of health status should be considered when developing policy recommendations to combat the effects of tobacco smoking on a population. The costs of morbidity and mortality associated with SHS are directly or indirectly borne by many. Employers bear additional costs for health insurance premiums used to pay for the treatment required for people with the SHS preventable diseases. Employers additionally assume many of the indirect costs associated with tobacco use and SHS such as increased employee sick leave due to SHS exposure or lost work time for smoke breaks. Consumers may assume the additional costs of SHS associated with

their portion of insurance premiums and any additional coinsurance and/or co-payments associated with the hospitalization, physician and pharmaceutical costs resulting from exposure to SHS attributable diseases. Society assumes the cost burden for the uninsured population through the large amount of uncollected hospital revenues; taxpayers bear the cost of Medicaid benefits for indigents and for Medicare clients requiring treatment for SHS related diseases. Additionally, society as a whole endures the burden of premature loss of life. The lost productivity and opportunity cost of these losses have effects that carry on for many years.

It is important to use these data to educate consumers, business owners, legislators and policy makers to make them more aware of the huge economic consequences of SHS at the community level. It is the role of policy makers and government agencies to protect the health of its citizens and to promote the economic prosperity of the community.

## Recommendations

Policy recommendations resulting from this study include the following:

- Encourage the use of these findings to further educate the public, as well as community leaders and policy makers, about the health impacts and costs of SHS in Marion County;
- Encourage businesses and institutions that are not already 100 percent smoke-free to totally eliminate smoking at the workplaces, on their campuses including

schools, colleges and universities, day care centers, restaurants and other food or beverage service establishments;

- Strictly enforce no smoking restrictions in all public areas, and on business and school campuses;
- Provide more support for smoking cessation programs by businesses, health departments and health care providers; and.
- Encourage smokers not to smoke in shared areas.

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